

The Relationship Between Intellectual Capital and Information Technology: Findings Based on a Systematic Review

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Abstract: The world is experiencing a knowledge-based economy with a revolution in information technology, innovation, and telecommunications. The rise of the "new economy", driven by information and knowledge, has led to an increased interest in intellectual capital theory, which aims to manage intangible assets of organizations. Firms belonging to technology and knowledge-based industries recognize intellectual capital as the key knowledge base that contributes to the creation of a competitive advantage for the firm. This paper aims to answer the question "How are Intellectual Capital (IC) and Information Technology (IT) related?" through a systematic review based on four steps: 1) search conduction; 2) selection of papers based on their titles and abstracts; 3) content analysis of selected papers; 4) evidence mapping and discussions. The analyzed papers were categorized into five themes: "Statistical analysis or case study in IT companies from the Intellectual Capital perspective"; "IT as a tool for Intellectual Capital Management"; "Intellectual Capital or technology knowledge assets influencing innovation and development", "Intellectual Capital assets to evaluate a technology" and "Intellectual Capital theory as a way to understand and share knowledge in IT projects". Our findings evidenced that the Human Capital was the main dimension studied by the authors, followed by Structural Capital and Relational Capital. We believe that this work may help to clarify on Intellectual Capital Management procedures into Information Technology projects, thus opening new topics for future research.

Keywords: intellectual capital, information technology, systematic review

1. Introduction

The world is experiencing a knowledge-based economy with a revolution in information technology, innovation, and telecommunications. The rise of the "new economy", driven by information and knowledge, has led to an increased interest in intellectual capital theory, which aims to manage intangible assets of organizations. (Stewart, 1997; Edvinsson and Malone, 1997; Bontis, 2001).

Generating knowledge is a necessity in modern economies and, subsequently, the most important aspect is the economic value that can be attained from the knowledge assets created by key players in knowledge economies. Research evaluation has created the necessity for information systems to assist administrators in integrating data, information and knowledge in the calculation of the indicators for strategic planning, investment analysis and competitiveness (Cantú and Ceballos, 2010). According to Castro et al. (2013), one of the best ways for a firm to achieve a competitive advantage comes directly from continuous technological innovation.

Considering the relevance of these issues in the new economy, this research addresses the following question, which is of major significance for understanding how companies are dealing with the intellectual capital and Information Technology (IT): *1) How are Intellectual Capital (IC) and Information Technology (IT) related?*

Through this question we hope to understand better the role of IT in Intellectual Capital Management and how the organizations are dealing with intellectual capital in IT projects. This work is a starting point for further research that aims to deepen the Intellectual Capital theory as a way to understand and share knowledge in IT projects. To reach this objective, this paper aims to identify what evidence is available through a systematic review-based approach (Kitchenham and Charters, 2007).

This paper has four further sections. Section two aims to present a literature review about Intellectual Capital and Information Technology, showing relationship between these topics. Section three outlines our research method, based on a systematic review approach. In the Section four we present the results obtained by the

conduction of the research method, our findings and discussions. Finally, conclusions and suggestions for future works are presented.

2. Background and related work

According to Edvinsson and Sullivan (1996), intellectual capital can be defined as “*knowledge that can be converted into value*”. Roos et al. (1998) define intellectual capital through three basic dimensions: human capital, structural capital, and relational capital. Human capital comprises all business capital embedded in employees and not owned by the organization. This capital may be taken away by employees, and includes employees and managers' competence, experience, knowledge, skills, attitude, commitment, and wisdom. Structural capital is defined as workflow, operation processes, specific methods, business development plans, information technology systems, and cooperative culture, etc. Relational capital includes all value of stakeholders, customers, and supplier relations (Hsu and Fang, 2009). Information technology (IT) is the application of computers and telecommunications equipment to store, retrieve, transmit and manipulate data, often in the context of a business or other enterprise (Daintith, 2009). There are several studies involving intellectual capital theory and Information Technology, analyzing those influences on innovation and performance, for example. Since an Information Technology project, such as an information system development project, is a knowledge intensive process and knowledge is counted as the most critical resource, intellectual capital serves as a good starting point for investigating this issue (Hsu, 2014).

Steinfeld et al. (2010) explores how some uses of information and communication technologies (ICTs), as well as having social capital and other means of access to knowledge resources, are related to company performance in a knowledge-intensive business cluster. The companies reported better performance outcomes when ICT use was aimed at accessing and enhancing human and intellectual capital, such as use of online databases for recruitment, intranets to enhance employee access to information and education, and collaborative tools to connect with off-premise researchers. Tai and Chen (2009) propose a suitable model for intellectual capital performance evaluation by combining 2-tuple fuzzy linguistic approach with multiple criteria decision-making method. The feasibility of the model is demonstrated by the result of evaluation for a technology company in Taiwan.

Delgado-Verde et al. (2011) indicate that social and relational capital influence on technological innovation for the case of Spanish technology-based industries, emphasizing the inter-organizational relationships among the firm with its customers and suppliers. In another way, Vega-González et al. (2010) propose a four-step method to evaluate a technology which includes the definition of a Precompetitive Technology (PT) value range based on cost and market approaches, expected incomes, present value and scoring in order to determine the relative weights of the primary aspects of the intellectual capital behind the technology.

Harison and Koski (2010) investigate how different properties of software firms, such as size, age, intellectual capital, absorptive capacity, and ownership structure affect their decisions to base their business strategies on Open Source Software (OSS) supply or proprietary distribution of products and services. Their empirical findings indicate that the adoption of technologically advanced strategies requiring complex legal and managerial knowledge, such as the OSS supply strategy, demands relatively highly educated employees. Current research suggests that intellectual capital can be managed using information technologies. Huang et al. (2013) work the Intellectual Capital (IC) adopting the concept of Corporate Memory (CM) that is considered a way to implement the structural dimension of IC. The activities involved with CM construction are automated using analytical knowledge (AK), which is extracted from data storage systems and domain experts by aggregating information, where data analysts, knowledge workers, and knowledge users are involved in a knowledge discovery process. On the other hand, Colomo-Palacios et al. (2011) propose a technological solution which provides support for key human capital management activities such as: workforce acquisition, workforce administration, organization management and planning, workforce time management, payroll, compensation management skills and competency management performance management, career and succession planning, motivation. Finally, Bedford (2012) suggests semantic technologies for support the configuration and embedding of human knowledge (human capital) or knowledge organization systems.

3. Research method

The research method used is based on a systematic review approach in order to do a comprehensive and unbiased search distinguished from a traditional review of the literature (Kitchenham and Charters, 2007). The

process covered some phases of a systematic review, resulting in a thematic map with its respective synthesis. Each step and their outcomes are shown in Figure 1.

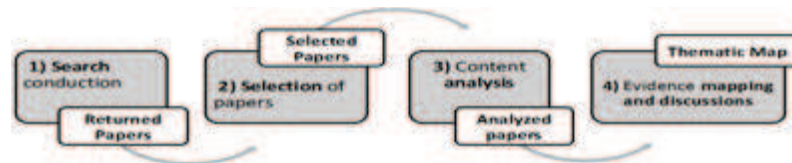


Figure 1: Research methodology (adapted from Kitchenham and Charters, 2007)

1. Search conduction: The search process was done through an automatic search in the following engines: ScienceDirect (<http://www.sciencedirect.com/>), Wiley Online Library (<http://onlinelibrary.wiley.com/>) and Emerald Insight (<http://www.emeraldinsight.com/>). The ScienceDirect engine contains papers from the main reference Journal in the research area: *Information & Management Journal* (an Elsevier publication). It serves researchers which design, implement and manage information Systems Applications. *Journal of Intellectual Capital* is another relevant Journal for this research and its papers can be searched in Emerald Insight engine. The string used in the search was based on two terms of general research question: Intellectual Capital and Information Technology. In order to find the largest possible number of papers, we used the synonymous of some keywords, as we can see in Table 1.

Table 1: Search strings adopted in the research.

Search Strings
"Intellectual Capital" AND ("Information Technology" OR "IT" OR "Information System Development" OR "Software Development").

2. Selection of papers: All titles and abstracts were read in order to remove the papers not related to the scope of this research, which resulted in 49 selected papers. In the ScienceDirect engine we had 28 papers selected (25% of 113 papers); in the Wiley engine we had 3 papers selected (4% of 74 papers); and in the Emerald Insight engine we had 18 papers selected (17% of 103 papers).

3. Content Analysis: All selected papers were read and analyzed according to inclusion and exclusion criteria which are described in Table 2.

Table 2: Inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> - Only journal papers were considered. - The papers give relevance to the Intellectual Capital and Information Technology themes. 	Papers that are not focused on the themes Intellectual Capital and / or Information Technology were discarded.

According to this analysis, 16 of the selected papers (32%) were discarded. This phase resulted in 17 papers by the ScienceDirect engine (61% of 28 selected papers by the phase 2); 2 papers by the Wiley engine (67% of 3 selected papers by the phase 2); and 14 papers by the Emerald Insight (78% of 18 selected papers by the phase 2). We can see the result of the content analysis in Figure 2, which shows the quantity of selected papers by phase of the methodology.

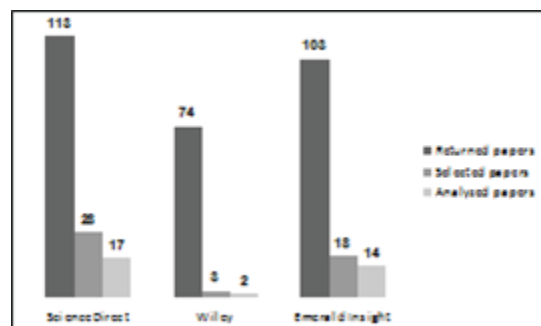


Figure 2: Quantity of studies in each phase of the search

4. Evidence Mapping and Discussions: All selected papers were analyzed and grouped by theme in order to answer the research question. The analyzed papers were categorized into five themes: A) "Statistical analysis or case study in IT companies from the Intellectual Capital perspective"; B) "IT as a tool for Intellectual Capital

Management"; C) "Intellectual Capital or technology knowledge assets influencing innovation and development"; D) "Intellectual Capital assets to evaluate a technology"; and E) "Intellectual Capital theory as a way to understand and share knowledge in IT projects". All of the papers analyzed by the research method were listed in Table 3. The references numbers are preceded by P (Paper) in order to facilitate their identification and as a result of this phase we can see the references categorized by theme. Some thematic maps were proposed to summarize the findings and they are discussed in the next section of this paper.

Table 3: Analyzed papers

ID	Reference (Science Direct)	Themes
[P1]	Huang, C. C., Fan, Y. N., Chern, C. C., Yen, P. H. (2013) <i>Measurement of analytical knowledge-based corporate memory and its application</i> , Decision Support Systems, Vol. 54, No. 2, pp. 846-857.	B
[P2]	Castro, G. M., Delgado-Verde, M., Navas-López, J. E., Cruz-González, J. (2013) <i>The moderating role of innovation culture in the relationship between knowledge assets and product innovation</i> , Technological Forecasting and Social Change, Vol. 80, No. 2, pp. 351-363.	A, C
[P3]	Steinfeld, C., Scupola, A., López-Nicolás, C. (2010) <i>Social capital, ICT use and company performance: Findings from the Mexican Valley Biotech Cluster</i> , Technological Forecasting and Social Change, Vol. 77, No. 7, pp. 1156-1166.	A, B
[P4]	Harrison, E., Koski, H. (2010) <i>Applying open innovation in business strategies: Evidence from Finnish software firms</i> , Research Policy, Vol. 39, No. 3, pp. 351-359.	A, C
[P5]	Cantu, F. J., Ceballos, H. G. (2010) <i>A multiagent knowledge and information network approach for managing research assets</i> , Expert Systems with Applications, Vol. 37, No. 7, pp. 5272-5284.	B
[P6]	Castro, G. M., Salazar, E. M. A., López, J. E. N., Sáez, P. L. (2009) <i>El papel del capital intelectual en la innovación tecnológica. Un aplicación a las empresas de servicios profesionales de España</i> , Cuadernos de Economía y Dirección de la Empresa, Vol. 12, No. 40, pp. 83-109.	C
[P7]	Hsu, J. S., Chu, T., Lin, T., and Lo, C. (2014) <i>Coping knowledge boundaries between information system and business disciplines: An intellectual capital perspective</i> , Information & Management Journal, Vol. 51, No. 2, pp. 283-295.	A, E
[P8]	Hung, C., Chou, J. C., Rooh, H. (2010) <i>Evaluating a national science and technology program using the human capital and relational asset perspectives</i> , Evaluation and program planning, Vol. 33, No. 4, pp. 487-497.	A
[P9]	Vega-González, L. R., Qureshi, N., Kolokoltsev, O. V., Ortega-Martínez, R., Biesse, J. M. S. (2010) <i>Technology valuation of a scanning probe microscope developed at a university in a developing country</i> , Technovation, Vol. 30, No. 9-10, pp. 533-539.	A, D
[P10]	Lu, W., Hung, S. (2011) <i>Exploring the operating efficiency of Technology Development Programs by an intellectual capital perspective—A case study of Taiwan</i> , Technovation, Vol. 31, No. 8, pp. 374-383.	A
[P11]	Colomo-Palacios, R., Fernandes, E., Soto-Acosta, P., Sabbagh, M. (2011) <i>Software product evolution for Intellectual Capital Management: The case of Meta4 PeopleNet</i> , International Journal of Information Management, Vol. 31, No. 4, pp. 395-399.	B
[P12]	Gavious, I., Russ, M. (2009) <i>The valuation implications of human capital in transactions on and outside the exchange</i> , Advances in Accounting (2009) Vol. 25, No. 2, pp. 165-173.	A
[P13]	Tai, W. S., Chen, C. T. (2009) <i>A new evaluation model for intellectual capital based on computing with linguistic variable</i> , Expert Systems with Applications, Vol. 36, No. 2 part 2, pp. 3483-3488.	A
[P14]	Delgado-Verde, M., Martín-de-Castro, G., Navas-López, J. E., Cruz-González, J. (2011) <i>Capital social, capital relacional e innovación tecnológica. Una aplicación al sector manufacturero español de alta y media-alta tecnología</i> , Cuadernos de Economía y Dirección de la Empresa, Vol. 14, No. 4, pp. 207-221.	A, C
[P15]	Adam, M. S., Urquhart, C. (2009) <i>No man is an island: Social and human capital in IT capacity building in the Maldives</i> , Information and Organization, Vol. 19, No. 1, pp. 1-10.	C
[P16]	Hsu, V., Fang, W. (2009) <i>Intellectual capital and new product development performance: The mediating role of organizational learning capability</i> , Technological Forecasting and Social Change, Vol. 76, No. 5, pp. 664-677.	A, C
[P17]	Liberona, D., Ruiz, M. (2013) <i>Análisis de la implementación de programas de gestión del conocimiento en las empresas chilenas</i> , Estudios Gerenciales, Vol. 29, No. 127, pp. 151-160.	B
ID	Reference (Wiley Online Library)	Theme
[P18]	Kim, D. Y., Kumar, V., Kumar, U. (2009) <i>A Framework of Intellectual Capital Management Based on ISO 9001 Quality Management System: The Case Study of ISO 9001 Certified Public R&D Institute</i> , Knowledge and Process Management, Vol. 16, No. 4, Pages: 162-173.	A
[P19]	Bedford, D. (2012) <i>Enabling Personal Knowledge Management with Collaborative and Semantic Technologies</i> , Society for Information Science and Technology, pp. 32-40.	B
ID	Reference (Emerald Insight)	Theme
[P20]	Ginh, T. L., Rinfret, L., Raymond, L., Thi, B. D. (2013) <i>Towards the reconciliation of knowledge management and e-collaboration systems</i> , Interactive Technology and Smart Education, Vol. 10, No. 2, pp.95-115.	B
[P21]	Omar, F., Christian, N. (2014) <i>Improving the information environment for analysts: Which intellectual capital disclosures matter the most?</i> , Journal of Intellectual Capital, Vol. 15, No. 1, pp. 142-156.	A
[P22]	Delgado-Verde, M., Navas-López, J. E., Cruz-González, J., Amores-Salvado, J. (2011) <i>Radical innovation from relations-based knowledge: empirical evidence in Spanish technology-intensive firms</i> , Journal of Knowledge Management, Vol. 15, No. 5, pp.722-737.	A
[P23]	Karagiannis, D., Nemetz, M., Bayer, F. (2009) <i>A method for comprehensive intellectual capital management and reporting: The case of BOC Information Systems</i> , Journal of Intellectual Capital, Vol. 10 Iss: 1, pp.93-108.	A
[P24]	Calisir, F., Gumussay, C. A., Bayraktaroglu, A. E., Deniz, E. (2010) <i>Intellectual capital in the quoted Turkish ITC sector</i> , Journal of Intellectual Capital, Vol. 11, No. 4, pp. 538-554.	A
[P25]	Ahmed, A., Al-Roubaie, A. (2012) <i>Building a knowledge-based economy in the Muslim world: The critical role of innovation and technological learning</i> , World Journal of Science, Technology and Sustainable Development, Vol. 9, No. 2, pp.76 – 98.	B, C
[P26]	Chen, M., Chang, Y. (2013) <i>The impacts of human capital in enhancing new venture's performance: Competence, motivation and creativity</i> , Journal of Knowledge-based Innovation in China, Vol. 5, No. 2, pp.146-168.	A
[P27]	Kim, D., Grant, G. (2010) <i>E-government maturity model using the capability maturity model integration</i> , Journal of Systems and Information Technology, Vol. 12, No. 3, pp. 230-244.	D
[P28]	Huang, C. C., Tayles, M., Luther, R. (2010) <i>Contingency factors influencing the availability of internal intellectual capital information</i> , Journal of Financial Reporting and Accounting, Vol. 8, No. 1, pp. 4-21.	B
[P29]	Joshi, M., Ubha, D. S., Sidhu, J. (2012) <i>Intellectual capital disclosures by Indian and Australian information technology companies: A comparative analysis</i> , Journal of Intellectual Capital, Vol. 13, No. 4, pp. 582-598.	A
[P30]	Cantu, F. J., Bustani, A., Molina, A., Moreira, H. (2009) <i>A knowledge-based development model: the research chair strategy</i> , Journal of Knowledge Management, Vol. 13, No. 1, pp. 154-170.	A, B
[P31]	Miriam Delgado-Verde, Gregorio Martín-de Castro, José Emilio Navas-López, (2011) <i>Organizational knowledge assets and innovation capability: Evidence from Spanish manufacturing firms</i> , Journal of Intellectual Capital, Vol. 12, No. 1, pp. 5-19.	C
[P32]	Wang, Z., Wang, N., Liang, H. (2014) <i>Knowledge sharing, intellectual capital and firm performance</i> , Management Decision, Vol. 52, No. 2, pp. 230-258.	A
[P33]	Metaxiotis, K. (2009) <i>Exploring the rationales for ERP and knowledge management integration in SMEs</i> , Journal of Enterprise Information Management, Vol. 22, No. 1/2, pp. 51-62.	B

4. Findings and discussions

After evidence mapping, the selected themes resulting from this analysis were related to the evidence obtained in the 33 papers in order to describe in an interpretive way the collected information and also to ensure the traceability of results. Our findings evidenced that the Human Capital was the main dimension studied by the authors, followed by Structural Capital and Relational Capital.

The interactions between the findings by theme are shown in Figures 3, 4, 5, 6 and described in the following subsections.

4.1 Statistical analysis or case study in IT companies from the intellectual capital perspective

Among the included studies, 57% had discussions on Statistical Analysis or Case Study in IT companies from the Intellectual Capital perspective. Some of the papers were categorized in more than one theme. To avoid data replication, in this section we describe only the results of papers that fit this theme only.

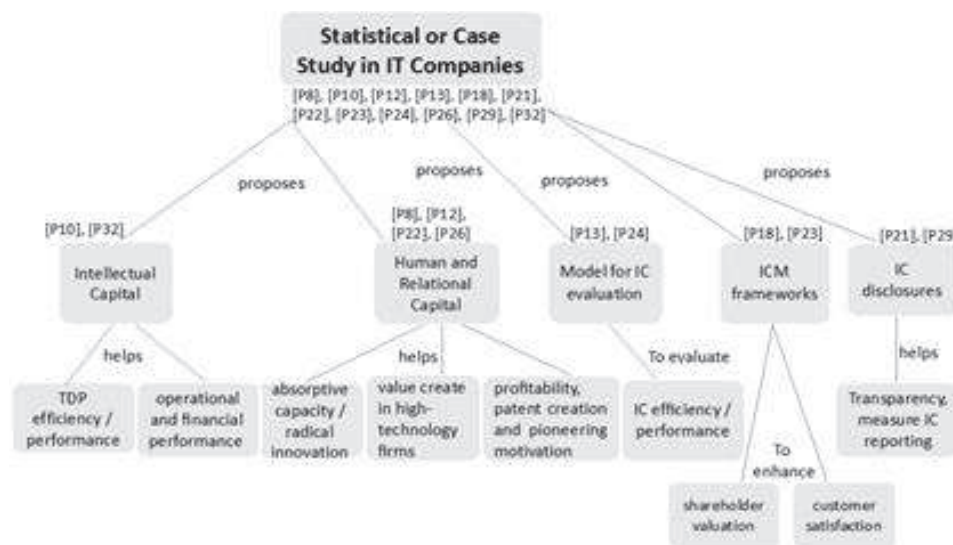


Figure 3: Statistical analysis or case study in IT companies from the intellectual capital perspective

The authors of P8 studied the relationship between good human capital and relational assets and concluded that within governmental technology policy in Taiwan influences in absorptive capacity.

The findings of the study P10 point to the importance of intellectual capital in achieving high levels of Technology Development Program (TDP) efficiency and performance.

The paper P12 concluded that the human capital comprising a more sizable portion of the value of high-technology firms than of low-technology firms. The authors examined the valuation implications of human capital both for a broad sample of firms and for subsamples of high and low technology firms. The method proposed in paper P13 is applied to evaluate the performance management of intellectual capital for a high-technology company in Taiwan. It is feasible to manipulate the evaluation processes of integration and avoid the information loss effectively.

The paper P18 argues that the ISO standard and IC management have the similar objectives: that is the maximization of shareholder valuation and the enhancement of customer satisfaction. The IC framework based on ISO 9001 helps to reach these objectives.

The paper P21 examines the effect of intellectual capital disclosure on analysts of some biotechnology firms. This study shows that analysts are more likely to follow firms with high intellectual capital disclosure, because of the transparency and information environment. In the same way, the paper P29 compares IC disclosures of software and information technology sector companies in a developed nation Australia and a fast developing nation India. Findings show that top five Indian IC disclosing companies also performed better than the Australian companies.

Relational and Social Capital, according to paper 22, have a significantly positive influence on radical innovation developed by firms in the sample, although those relationships maintained with external agents seem to have a higher impact.

When applying the framework for intellectual capital management proposed by the paper P23, managers, employees, external stakeholders, experts and academics can proceed on the question of how to achieve comparable and expressive intellectual capital reports.

The paper P4 proposes to compare quoted information technology and communication companies on the Istanbul Stock Exchange (ISE), in terms of intellectual capital efficiency, using Value Added Intellectual Coefficient (VAIC) assessment.

The authors of the paper P26 found that entrepreneurial experience, manpower and creativity have influence on profitability, patents creation and pioneering motivation.

The paper P32 aims to investigate the impact of knowledge sharing (KS) on firm performance and the mediating role of intellectual capital (IC). Human, structural and relational capital, enhance both operational and financial performance of firms. Explicit KS has a greater effect on financial performance than operational performance, whereas tacit KS has a greater impact on operational performance than financial performance.

4.2 IT as a tool for intellectual capital management

Among the included studies, 33% had discussions on theme B, i.e., IT as a tool for Intellectual Capital Management. These studies emphasize the importance of tools in the automation of activities to support the management of intangible assets in organizations. The excerpts from the analysis of the studies included in this research are summarized in Figures 4 and Figure 5 which represent two Thematic Maps showing the relationship between the main findings obtained by the papers. Analyzing the Figure 4, five studies suggest different information technology tools as a way to manage intellectual capital in organizations. P1, P5 and P17 relate the tools to practices of knowledge management and P3 and P11 relate the tools to practices of human resource management, such as information and education, recruitment, payroll, skills, career and motivation.

The paper P1 works the Intellectual Capital (IC) adopting the concept of Corporate Memory (CM) that is constructed using analytical knowledge which is extracted from data storage systems. The paper P5 suggests the integration of current knowledge and information technologies to manage knowledge in novel ways in modern organizations. Research reports, online consultations, search engine, web services and data mining are some examples of tools indicated by the authors. The paper P17 presents several examples of tools that can be adopted to support knowledge management in organizations such as: corporate chats, wikis, forums, knowledge bases, online libraries, instructional videos and platforms of customer relationship management (as CRM).

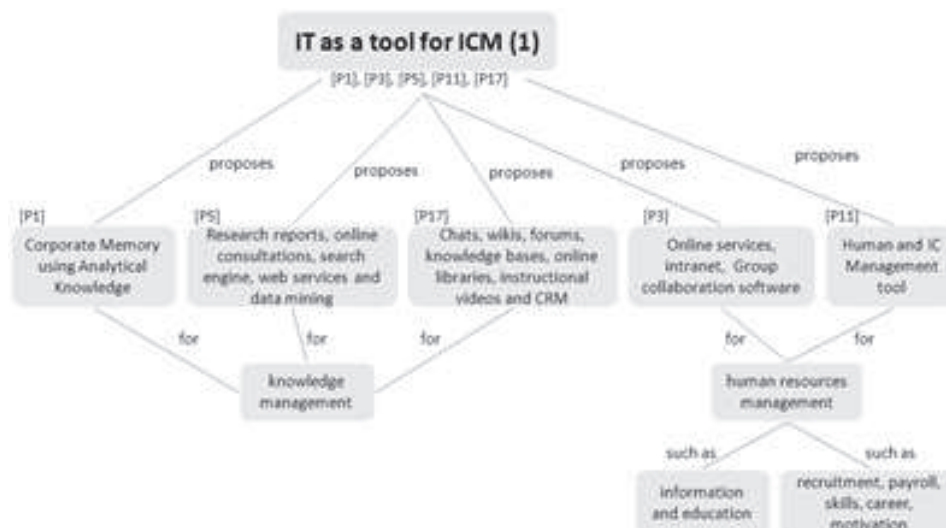


Figure 4: "IT as a tool for ICM" thematic map (1)

The paper P3 explores how some uses of information and communication technologies (ICTs), as well as having social capital and other means of access to knowledge resources, are related to company performance in a knowledge-intensive business cluster. The authors report that ICT usage can be useful to enhance human capital, either by helping to locate and recruit new skilled workers, strengthen human capital through ICTs-enabled information access or training, or supporting collaboration. The paper P11 presents a software solution focused on the support for key human capital management activities such as: workforce acquisition, workforce administration, organization management and planning, workforce time management, payroll, compensation management skills and competency management, performance management, career and succession planning, and motivation.

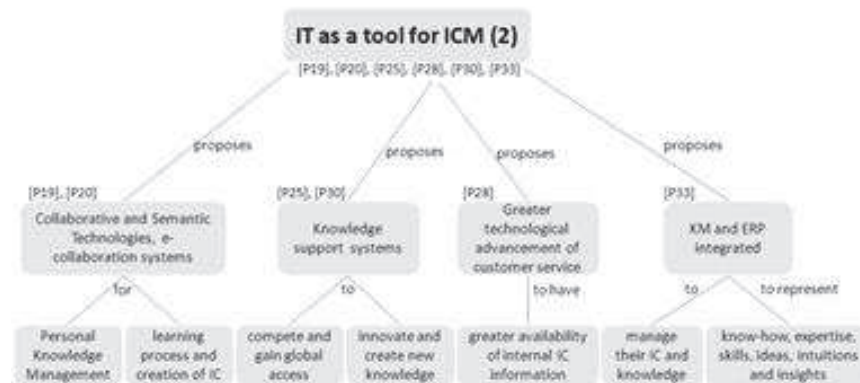


Figure 5: “IT as a tool for ICM” thematic map (2)

Analyzing the Figure 5, other six studies suggest different information technology tools as a way to manage intellectual capital in organizations. The authors of these studies list the benefits that can be reached using some information technology tools.

The paper P19 proposes the use of collaborative and semantic technologies for realizing Personal Knowledge Management, which is a formal profile where individuals can assume ownership, active management and control over information about themselves, i.e., they can manage this profile as their own intellectual capital. The paper P20 reports that the use of e-collaboration systems can help the promotion of learning process in an organization and contribute to the creation of intellectual capital.

The papers P25 and P30 suggest that the use of knowledge support systems has a positive influence on competition, gain of global access, innovation and new knowledge creation. P25 reports that local enterprises must develop technologies aiming at empowering the economy capabilities to innovate and create new knowledge through linkages, learning, acquiring, assessing, implementing and searching.

The paper P28 defines technology from three dimensions: customer service, information system and manufacturing technology. The author affirms that companies with greater technological advancement of customer service have greater availability of internal Intellectual Capital information.

Finally, the paper P33 reports that the success of a small business can be linked to how well they manage their intellectual capital and knowledge (to represent know-how, expertise, skills, ideas, intuitions and insights). The authors suggest that the integration of ERP systems and Knowledge Management (KM) can support small and medium enterprises in minimizing costs, improving the quality of products and services, and increasing customer satisfaction.

4.3 Intellectual capital or technology knowledge assets influencing innovation and development

Among the analyzed studies, 24% had discussions on theme C, i.e., Intellectual Capital or Technology Knowledge assets influencing Innovation and Development. The excerpts from the analysis of the studies included in this research are presented below and Figure 6 represents a Thematic Map showing the relationship between the main findings obtained by the papers.

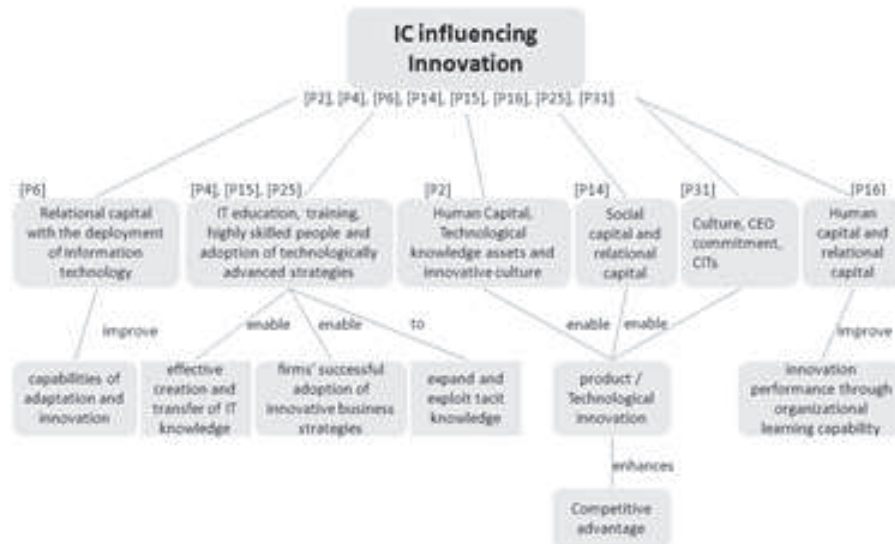


Figure 6: “IC influencing innovation” thematic map

Analyzing the Figure 6, eight studies present that the relationship between intellectual capital and information technology contribute to innovation in the organizations and demonstrate some benefits related to these issues.

The paper P6 affirms that the factors of innovation from relational capital, along with the deployment of information technology by the company, reveal the close and continuous relationships that companies should have to its customers in order to improve their capabilities of adaptation and innovation, constituting the reputation one of the most important assets you can develop businesses in this area.

The empirical findings of the paper P4 indicate that the adoption of technologically advanced strategies demands relatively highly educated employees, which is a consequence of investment in individual capital and it is essential for the firms’ successful adoption of innovative business strategies. In the same way, the paper P15 reports the importance of IT education and training for both the successful use of IT, and effective creation and transfer of IT knowledge. The paper P25 affirms that the innovation empowers the economy by increasing productivity, enhancing technological learning and creating knowledge. Acquiring external skills and technical knowledge is a way to expand and exploit tacit knowledge for building capacity to innovation.

The paper P2 argues that one of the best ways for a firm to achieve a competitive advantage comes directly from continuous technological innovation. The findings obtained show the positive and direct effects of human capital, technological knowledge assets, and innovation culture on product innovation.

From the perspective of open innovation, the paper P14 affirms that social capital and relational capital, as key to the achievement of technological innovation factors of an organization, are configured business success.

The paper P31 highlights the importance of culture and CEO commitment towards innovation, as well as the role played by communication and information technologies (CITs) within high and medium-high manufacturing firms.

Finally, findings of the paper P16 show that human capital and relational capital actually improve new product development performance through organizational learning capability.

4.4 Intellectual capital assets to evaluate a technology

Among the included studies, 6% had discussions on Intellectual Capital assets to evaluate a Technology. The excerpts from the analysis of the studies included in this research are presented below.

The paper P9 presents a four-step method with the definition of a Precompetitive technology (PT) value range based on cost and market approaches, expected incomes, present value and scoring in order to determine the relative weights of the primary aspects of the intellectual capital behind the technology.

The paper P27 proposes a framework for assessing the maturity level of electronic government (e-government). The framework is composed of four input areas (human capital, structural capital, relational capital, and IT investment) and five maturity stages (web presence, interaction, transaction, integration, and continuous improvement). Employing the Intellectual Capital management process enables practitioners to effectively manage resources and auditors to assess the input area more objectively.

4.5 Intellectual capital theory as a way to understand and share knowledge in IT projects

Among the included studies, only 3% had discussions on Intellectual Capital theory as a way to understand and share knowledge in IT projects. Considering the small quantity of studies related to it this theme could be excluded. But it was kept because of the relevance of this theme, which was one of the main motivations to realize this systematic review.

The paper P7 presents Intellectual Capital theory as a way to start the investigation about the knowledge intensive process in an Information System Development (ISD) project. It argues that the business knowledge from users and technical knowledge from developers are considered the most critical resources. The authors propose the knowledge boundary spanning process to understand the elicited requirements as new knowledge jointly created by interactions between users and developers. Knowledge boundary refers to the knowledge delivery problems in which the tacit and sticky nature of localized knowledge may actually hinder problem solving and knowledge creation across functions (Nonaka, 1994 and Bourdieu, 1980, cited by Hsu et al. 2014).

The findings of the paper P7 highlighted how important effective knowledge boundary spanning is to both product and project quality. Furthermore, three dimensions of intellectual capital increased the degree to which knowledge boundary spanning was effective.

5. Conclusions

This study aimed to evaluate how the concepts of Intellectual Capital and Information Technology are related through a systematic review-based approach, which resulted in five themes: "Statistical analysis or case study in IT companies from the Intellectual Capital perspective"; "IT as a tool for Intellectual Capital Management"; "Intellectual Capital or technology knowledge assets influencing innovation and development", "Intellectual Capital assets to evaluate a technology" and "Intellectual Capital theory as a way to understand and share knowledge in IT projects".

The papers were analyzed in order to understand the Intellectual Capital dimension focused by the authors. Our findings evidenced that the Human Capital was the most studied dimension and the Relational Capital was the least studied. This evidence can be used to guide future research.

Important topics were highlighted by the studies, through the relationship between intellectual capital and information technology. Some of these topics were knowledge management, organizational learning, human resource management, innovation and new knowledge creation, absorptive capacity and competitive advantage.

In summary, as a result of this work, we can conclude that the adoption of intellectual capital management and information technology corroborates to reach the "new economy" needs. The knowledge-based economy focus in generates knowledge that can be attained from the knowledge assets created by key players.

We believe that this work may help to clarify Intellectual Capital Management procedures into Information Technology projects, thus opening new topics for future research.

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